

WHAT IS CLAIMED IS

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1. A method of controlling an array antenna part having a plurality of antenna elements arranged at a predetermined interval, comprising:

10 obtaining a predetermined evaluation function with respect to each of weighting coefficients to be applied to incoming signals arriving at a predetermined number of antenna elements, by perturbing each of the weighting coefficients at a sampling interval which is within one symbol time;
15 and

adjusting each of the weighting coefficients based on the evaluation function.

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2. The method of controlling the array antenna as claimed in claim 1, wherein the antenna part comprises one active antenna element to
25 transmit and receive a radio signal, and a plurality of passive antenna elements, and variable reactances are loaded to the plurality of passive antenna elements, said method comprising:

30 converting an analog signal received by the active antenna element into a digital signal by oversampling the analog signal at a predetermined period; and

adjusting reactances of the variable reactances to minimize or maximize the evaluation function, by
35 defining as the evaluation function a correlation coefficient which is obtained from a correlation of the digital signal and a known signal having a

predetermined pattern.

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3. The method of controlling the array antenna as claimed in claim 1, comprising:

adjusting phases and amplitudes of incoming signals arriving at the plurality of antenna elements;

converting analog signals received by the plurality of antenna elements into digital signals by oversampling the analog signals at a predetermined period; and

adjusting the phases and amplitudes to minimize or maximize the evaluation function, by defining as the evaluation function a correlation coefficient which is obtained from a correlation of the digital signals and a known signal having a predetermined pattern.

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4. An array antenna control apparatus for controlling an array antenna part having a plurality of antenna elements arranged at a predetermined interval, comprising:

a control unit having a part to obtain a predetermined evaluation function with respect to each of weighting coefficients to be applied to incoming signals arriving at a predetermined number of antenna elements, by perturbing each of the weighting coefficients at a sampling interval which is within one symbol time, and a part to adjust each of the weighting coefficients based on the evaluation function.

5. The array antenna control apparatus as claimed in claim 4, wherein said control unit compares the evaluation function and a predetermined threshold value, and adjusts each of the weighting
5 coefficients depending on a compared result.

10 6. The array antenna control apparatus as claimed in claim 4, wherein the antenna part comprises one active antenna element to transmit and receive a radio signal, and a plurality of passive antenna elements, and variable reactances are loaded
15 to the plurality of passive antenna elements,
said array antenna control apparatus comprising:

an analog-to-digital converter to convert an analog signal received by the active antenna element
20 into a digital signal by oversampling the analog signal at a predetermined period,

said control unit having an adjusting part to adjust reactances of the variable reactances to minimize or maximize the evaluation function, by
25 defining as the evaluation function a correlation coefficient which is obtained from a correlation of the digital signal and a known signal having a predetermined pattern.

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7. The array antenna control apparatus as claimed in claim 4, comprising:

35 an adjusting unit to adjust phases and amplitudes of incoming signals arriving at the plurality of antenna elements; and

an analog-to-digital converter to convert analog signals received by the plurality of antenna elements into digital signals by oversampling the analog signals at a predetermined period,

5 said control unit comprising an adjusting part to adjust the phases and amplitudes to minimize or maximize the evaluation function, by defining as the evaluation function a correlation coefficient which is obtained from a correlation of the digital
10 signals and a known signal having a predetermined pattern.

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8. The array antenna control apparatus as claimed in claim 7, comprising:

20 a radio frequency processing part coupled to the plurality of antenna elements, and including said adjusting unit.

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9. The array antenna control apparatus as claimed in claim 7, wherein said adjusting unit adjusts the phases and the amplitudes digitally or in analog form.

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10. The array antenna control apparatus as claimed in claim 4, comprising:

35 an adjusting unit to adjust phases of incoming signals arriving at the plurality of antenna elements; and

an analog-to-digital converter to convert analog signals received by the plurality of antenna elements into digital signals by oversampling the analog signals at a predetermined period,

5 said control unit comprising an adjusting part to adjust the phases to minimize or maximize the evaluation function, by defining as the evaluation function a correlation coefficient which is obtained from a correlation of the digital signals and a
10 known signal having a predetermined pattern.

15 11. The array antenna control apparatus as claimed in claim 6, wherein said adjusting part of the control unit adjusts the reactances of the variable reactances to minimize or maximize the evaluation function based on a gradient vector of
20 the correlation function.

25 12. The array antenna control apparatus as claimed in claim 7, wherein said adjusting part of the control unit adjusts the phases and the amplitudes to minimize or maximize the evaluation function based on a gradient vector of the
30 correlation function.

35 13. The array antenna control apparatus as claimed in claim 4, wherein incoming signals arriving at the plurality of antenna elements have

been transmitted by multicarrier transmission.

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14. The array antenna control apparatus as claimed in claim 6, comprising:

base converter to convert a time-based digital signal which is described in a time-domain and
10 output from said analog-to-digital converter into a frequency-based digital signal which is described in a frequency-domain,

said adjusting part of the control unit
defining as the evaluation function a correlation
15 coefficient which is obtained from a correlation of the frequency-based digital signal and a frequency-based known signal.

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15. The array antenna control apparatus as claimed in claim 7, comprising:

base converter to convert a time-based digital
25 signal which is described in a time-domain and output from said analog-to-digital converter into a frequency-based digital signal which is described in a frequency-domain,

said adjusting part of the control unit
30 defining as the evaluation function a correlation coefficient which is obtained from a correlation of the frequency-based digital signal and a frequency-based known signal.

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16. The array antenna control apparatus
as claimed in claim 6, wherein said adjusting part
of the control unit defines as the evaluation
function a correlation coefficient which is obtained
5 from a correlation of a time-based digital signal
which is described in a time-domain and output from
said analog-to-digital converter and a time-based
known signal.

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17. The array antenna control apparatus
as claimed in claim 7, wherein said adjusting part
15 of the control unit defines as the evaluation
function a correlation coefficient which is obtained
from a correlation of a time-based digital signal
which is described in a time-domain and output from
said analog-to-digital converter and a time-based
20 known signal.

25 18. The array antenna control apparatus
as claimed in claim 6, wherein the known signal is
generated from a signal for transmitting control
information within a frame employed by a
predetermined system or protocol.

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19. The array antenna control apparatus
35 as claimed in claim 7, wherein the known signal is
generated from a signal for transmitting control
information within a frame employed by a

predetermined system or protocol.

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20. The array antenna control apparatus as claimed in claim 6, comprising:

an impulse response obtaining unit to obtain an impulse response of a transmission path; and

10 a reference signal generator to generate a frequency-based reference signal which is described in a frequency-domain, by performing a Fourier transform on a convolution of the impulse response and a time-based known signal which is described in
15 a time-domain,

said adjusting part of the control unit defining as the evaluation function a correlation coefficient which is obtained from a correlation of a frequency-based digital signal which is output
20 from said analog-to-digital converter and the frequency-based reference signal.

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21. The array antenna control apparatus as claimed in claim 7, comprising:

an impulse response obtaining unit to obtain an impulse response of a transmission path; and

30 a reference signal generator to generate a frequency-based reference signal which is described in a frequency-domain, by performing a Fourier transform on a convolution of the impulse response and a time-based known signal which is described in
35 a time-domain,

said adjusting part of the control unit defining as the evaluation function a correlation

coefficient which is obtained from a correlation of a frequency-based digital signal which is output from said analog-to-digital converter and the frequency-based reference signal.

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22. The array antenna control apparatus
10 as claimed in claim 6, comprising:
 an impulse response obtaining unit to obtain an impulse response of a transmission path; and
 a reference signal generator to generate a
time-based reference signal which is described in a
15 time-domain, by performing a Fourier transform on a convolution of the impulse response and a time-based known signal,
 said adjusting part of the control unit
defining as the evaluation function a correlation
20 coefficient which is obtained from a correlation of a time-based digital signal which is output from said analog-to-digital converter and the time-based reference signal.

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23. The array antenna control apparatus
as claimed in claim 7, comprising:
30 an impulse response obtaining unit to obtain an impulse response of a transmission path; and
 a reference signal generator to generate a time-based reference signal which is described in a time-domain, by performing a Fourier transform on a
time-based reference signal which is described in a
35 convolution of the impulse response and a time-based known signal,
 said adjusting part of the control unit

defining as the evaluation function a correlation coefficient which is obtained from a correlation of a time-based digital signal which is output from said analog-to-digital converter and the time-based reference signal.

10 24. The array antenna control apparatus as claimed in claim 14, comprising:
a profile obtaining unit to obtain a delay profile statistically describing instantaneous characteristics of a transmission path; and
15 a reference signal generator to generate a frequency-based reference signal which is described in a frequency-domain, by performing a Fourier transform on a time-based reference signal which is described in a time-domain and generated based on
20 the delay profile,
said adjusting part of the control unit defining as the evaluation function a correlation coefficient which is obtained from a correlation of the frequency-based digital signal which is output
25 from said base converter and the frequency-based reference signal.

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25. The array antenna control apparatus as claimed in claim 15, comprising:
a profile obtaining unit to obtain a delay
35 profile statistically describing instantaneous characteristics of a transmission path; and
a reference signal generator to generate a

frequency-based reference signal which is described
in a frequency-domain, by performing a Fourier
transform on a time-based reference signal which is
described in a time-domain and generated based on
5 the delay profile,

said adjusting part of the control unit
defining as the evaluation function a correlation
coefficient which is obtained from a correlation of
the frequency-based digital signal which is output
10 from said base converter and the frequency-based
reference signal.

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26. The array antenna control apparatus
as claimed in claim 6, comprising:

a profile obtaining unit to obtain a delay
profile statistically describing instantaneous
20 characteristics of a transmission path; and

a reference signal generator to generate a
time-based reference signal which is described in a
time-domain, based on the delay profile,

said adjusting part of the control unit
25 defining as the evaluation function a correlation
coefficient which is obtained from a correlation of
a time-based digital signal which is output from
said analog-to-digital converter and the time-based
reference signal.

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27. The array antenna control apparatus
35 as claimed in claim 7, comprising:

a profile obtaining unit to obtain a delay
profile statistically describing instantaneous

characteristics of a transmission path; and
a reference signal generator to generate a
time-based reference signal which is described in a
time-domain, based on the delay profile,

5 said adjusting part of the control unit
defining as the evaluation function a correlation
coefficient which is obtained from a correlation of
a time-based digital signal which is output from
said analog-to-digital converter and the time-based
10 reference signal.

15 28. The array antenna control apparatus
as claimed in claim 14, comprising:

a transfer function obtaining unit to obtain a
transfer function describing instantaneous
characteristics of a transmission path in a
20 frequency-domain; and

a reference signal generator to generate a
frequency-based reference signal, based on the
transfer function,

25 said adjusting part of the control unit
defining as the evaluation function a correlation
coefficient which is obtained from a correlation of
the frequency-based digital signal which is output
from said base converter and the frequency-based
reference signal.

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29. The array antenna control apparatus
35 as claimed in claim 15, comprising:

a transfer function obtaining unit to obtain a
transfer function describing instantaneous

characteristics of a transmission path in a frequency-domain; and

5 a reference signal generator to generate a frequency-based reference signal, based on the transfer function,

said adjusting part of the control unit defining as the evaluation function a correlation coefficient which is obtained from a correlation of the frequency-based digital signal which is output from said base converter and the frequency-based reference signal.

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30. The array antenna control apparatus as claimed in claim 6, comprising:

20 a transfer function obtaining unit to obtain a transfer function describing instantaneous characteristics of a transmission path in a frequency-domain; and

25 a reference signal generator to generate a time-based reference signal which is described in a time-domain, by performing a Fourier transform on a frequency-based reference signal which is described in a frequency-domain and generated based on the transfer function,

30 said adjusting part of the control unit defining as the evaluation function a correlation coefficient which is obtained from a correlation of the time-based digital signal which is output from said analog-to-digital converter and the time-based reference signal.

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31. The array antenna control apparatus as claimed in claim 7, comprising:

5 a transfer function obtaining unit to obtain a transfer function describing instantaneous characteristics of a transmission path in a frequency-domain; and

10 a reference signal generator to generate a time-based reference signal which is described in a time-domain, by performing a Fourier transform on a frequency-based reference signal which is described in a frequency-domain and generated based on the transfer function,

15 said adjusting part of the control unit defining as the evaluation function a correlation coefficient which is obtained from a correlation of the time-based digital signal which is output from said analog-to-digital converter and the time-based reference signal.

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32. An array antenna control apparatus for controlling an array antenna part having a plurality of antenna elements arranged at a predetermined interval, comprising:

25 control means comprising means for obtaining a predetermined evaluation function with respect to each of weighting coefficients to be applied to incoming signals arriving at a predetermined number of antenna elements, by perturbing each of the weighting coefficients at a sampling interval which is within one symbol time, and means for adjusting each of the weighting coefficients based on the evaluation function.

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33. A computer-readable storage medium which stores a program for causing a computer to control an array antenna part having a plurality of antenna elements arranged at a predetermined

5 interval, said comprising:

a procedure causing the computer to obtain a predetermined evaluation function with respect to each of weighting coefficients to be applied to incoming signals arriving at a predetermined number
10 of antenna elements, by perturbing each of the weighting coefficients at a sampling interval which is within one symbol time; and

a procedure causing the computer to adjust each
15 of the weighting coefficients based on the evaluation function.

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